Effects of Land Cover, Flow, and Restoration on Stream Water Quality in the Portland, OR and Vancouver, WA Metro Area

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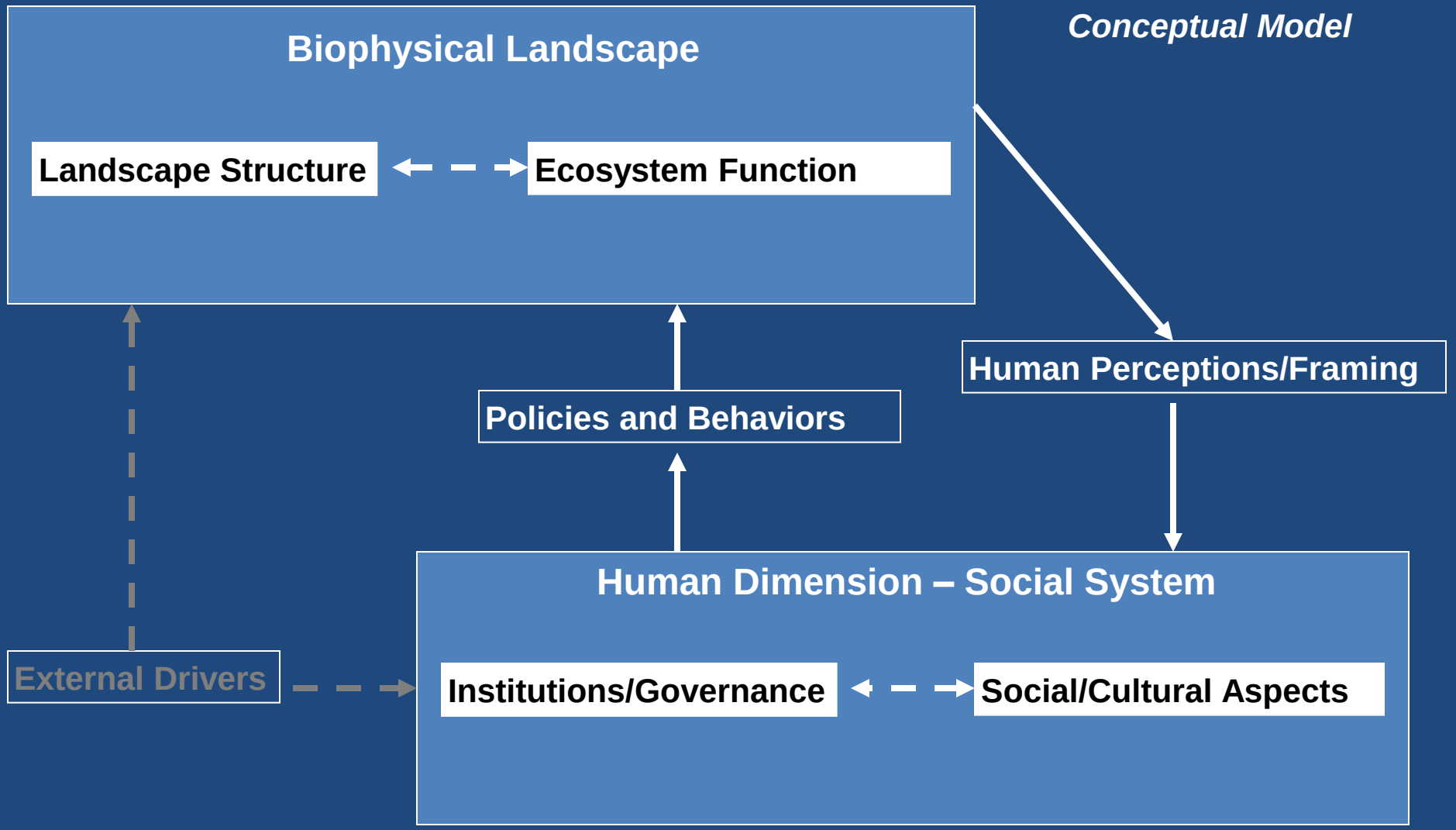
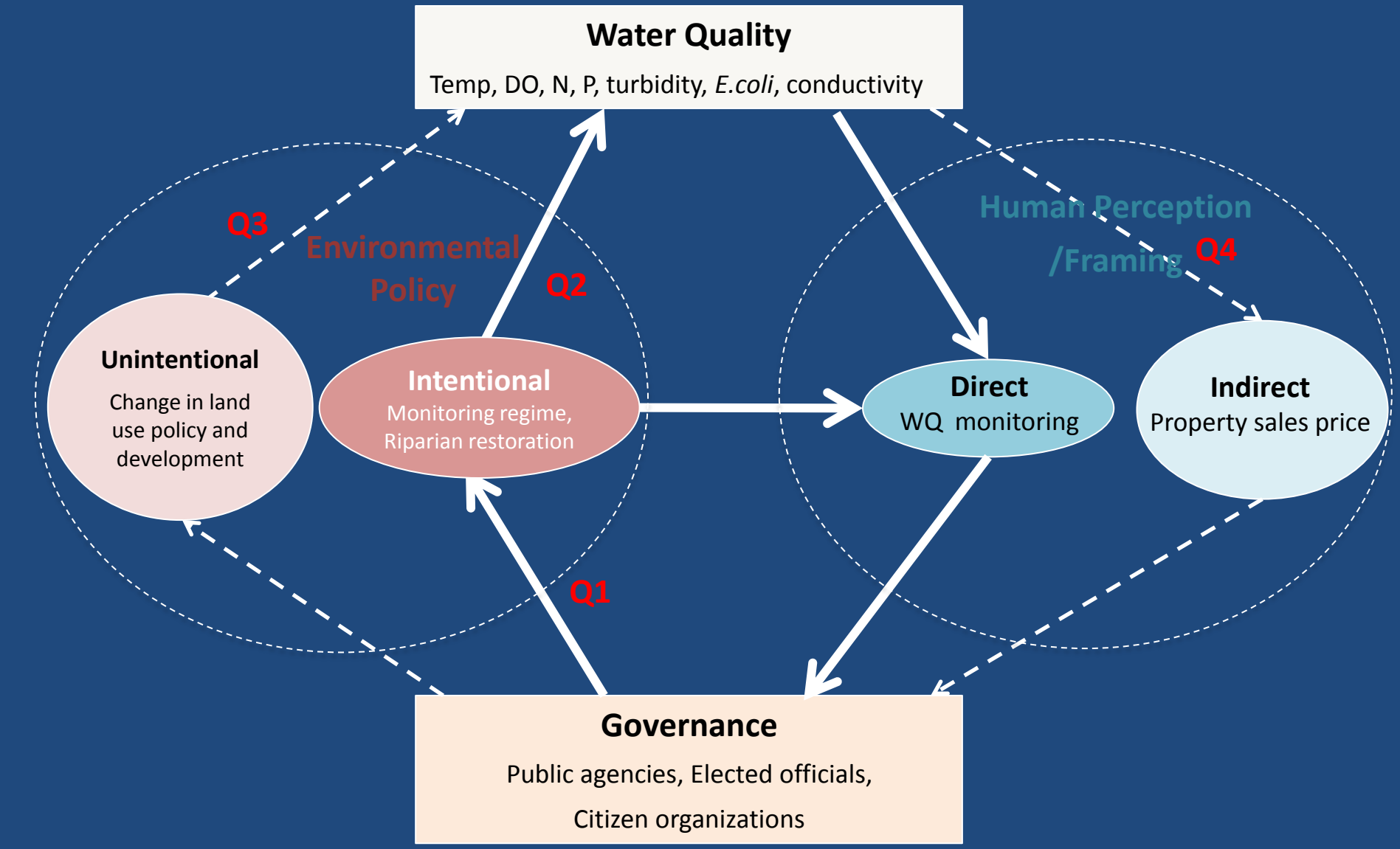
Portland Vancouver
ULTRA-Ex
Conceptual Model





Source: Chang et al. 2014 HESS

Represents direct and/or intentional linkage related to water quality (Water governance)

Represents indirect and/or unintentional linkage to water quality (Environmental governance)

Main Tasks

Task	Questions	Outcomes
Land cover vs. WQ (Q3)	-How does change in land development patterns, influence water quality over space and time?	-Pratt & Chang (2012) -Singh & Chang (in review) -Lee et al. (in review)
WQ vs. housing price (Q4)	What attributes of water quality affect property values? Are there any significant spatial variations?	- Noelwah et al. (in review)
Water governance vs. WQ (Q1)	How and why do water quality monitoring regimes differ across time and location?	-Chang et al. (2014)
Restoration vs. WQ (Q2)	To what extent has the intensity in stream restoration changed over time and in turn affected WQ?	*In preparation*

Research questions

- Does the relationship between land cover and WQ vary across scales along an urban-rural gradient?
- What is the trend of water quality?
- Did land cover change affect water quality?
- What is the role of restoration on stream water quality?

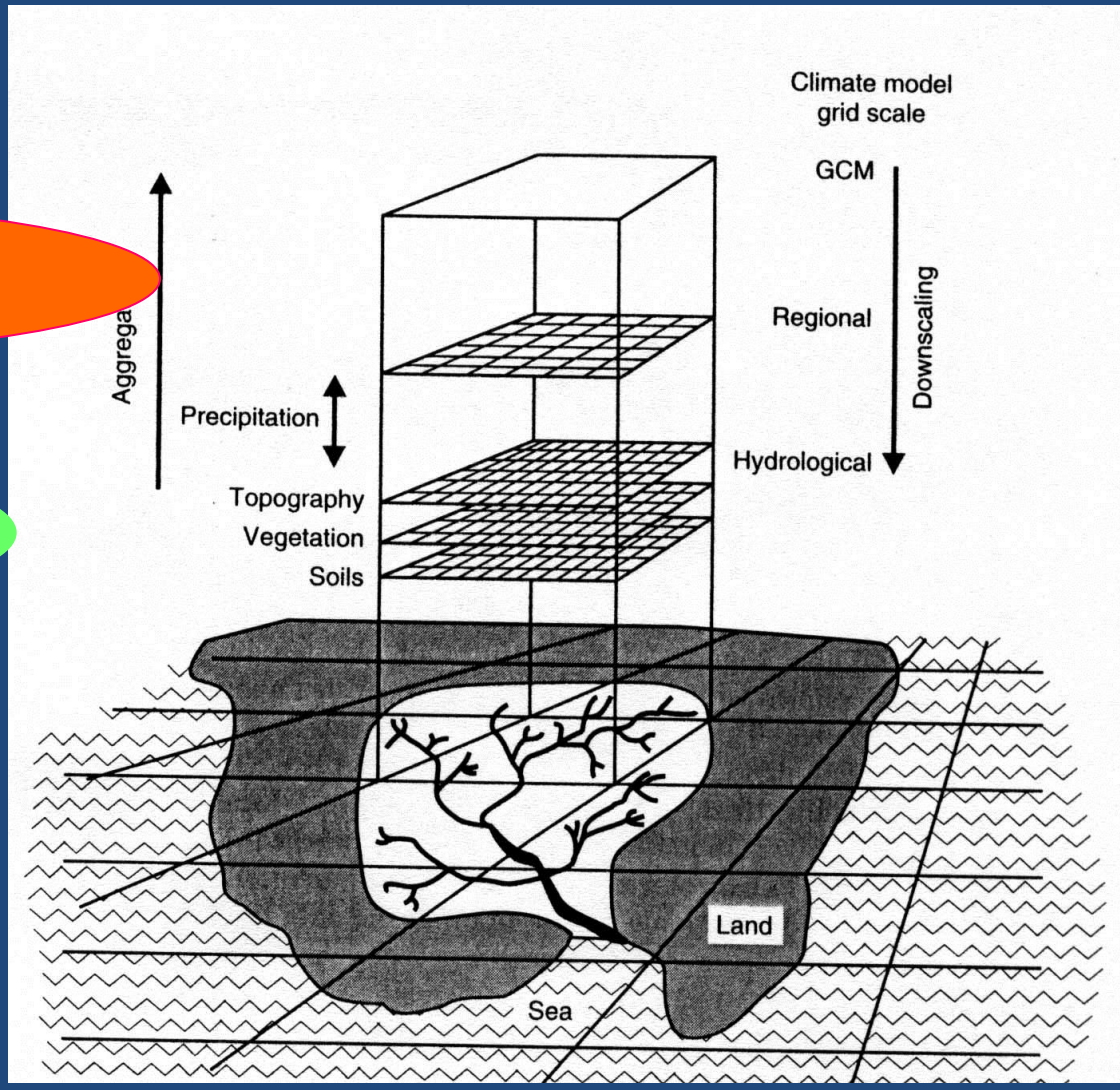
Scale influence on water quality

Climate, Geology

Vegetation

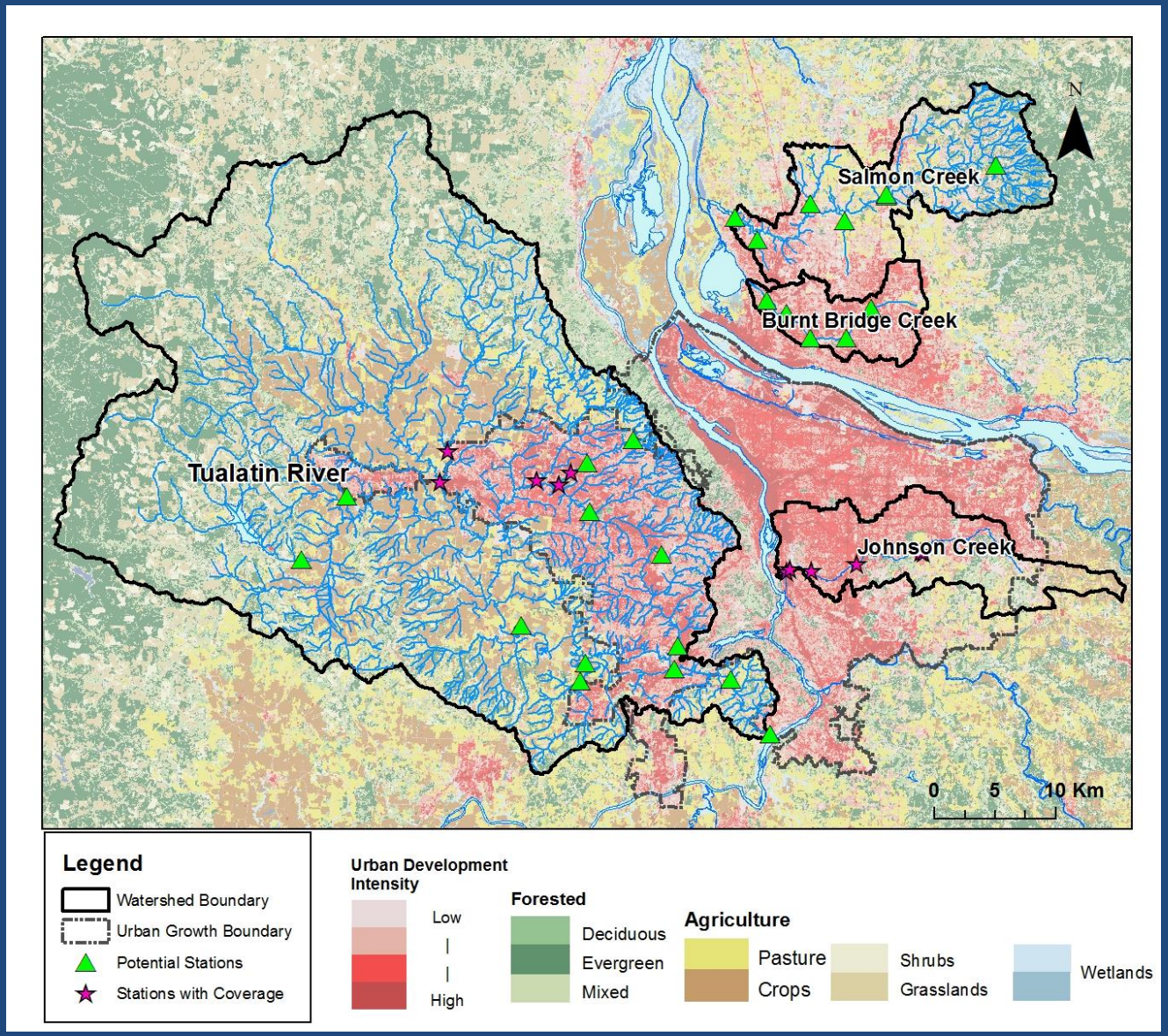
Topography

Water Quality



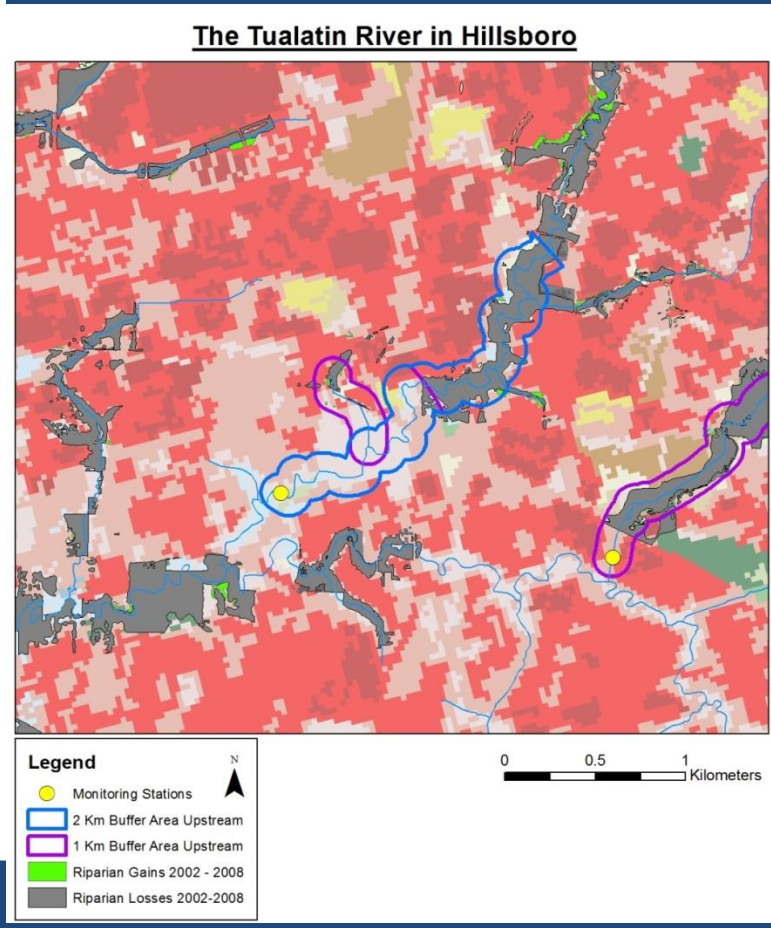
Source: Wilby and Wrigley. 1997. *Progress in Physical Geography*

Study watersheds



Data and methods

	Data	Analysis method
Land cover	USGS National Land Cover Data 1992, 2006	ArcGIS zonal statistic for % land cover
Riparian areas	Aerial photos	Manual digitation for gains and losses
Water Quality	Stream temperature DO Conductivity TS	Mann-Kendall test for trend analysis Multivariate statistic



Determinants of Water Quality at Two Scales

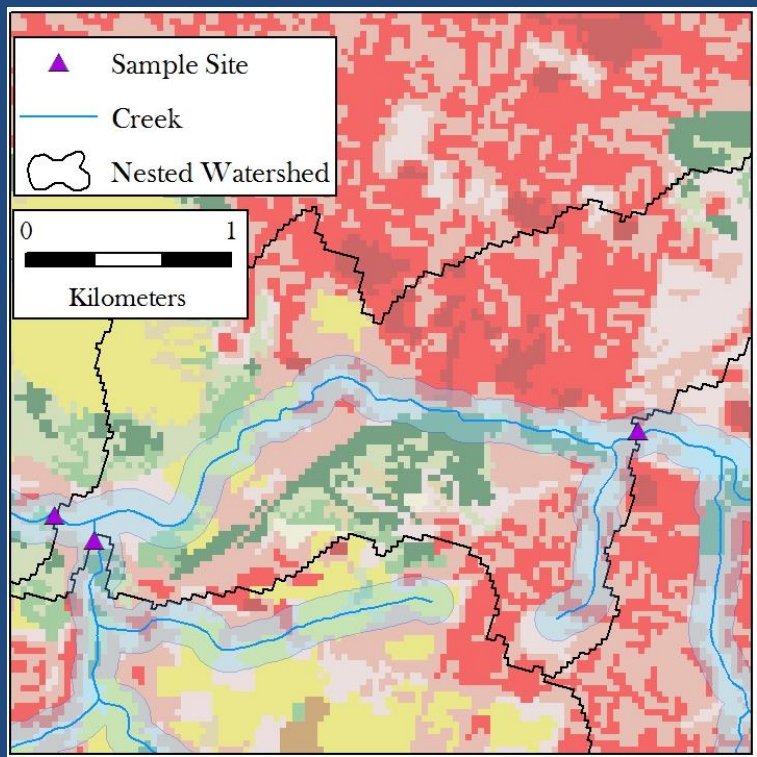
$$C_i = f(L_i, T_i, B_i)$$

C_i: Concentration at location i
L_i: Land cover attributes (% urban, % forest)
T_i: Topographic characteristics (slope, elevation)
B_i: Built environment (road density, housing density)

Example

Wet Season Conductivity = 47.801
+ 7.051 Road density + 0.879 % Agriculture
(Adjusted R^2 = 0.507)

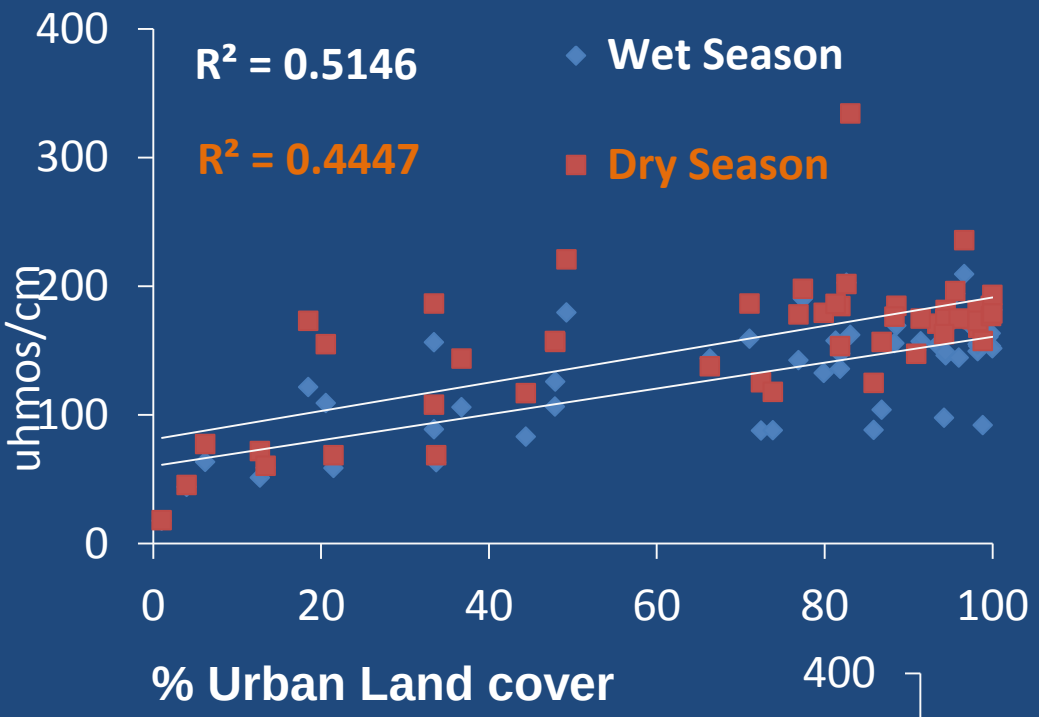
Dry Season Conductivity = 174.281
- .288 Elevation + 54.025 Road Density
(Adjusted R^2 = 0.458)

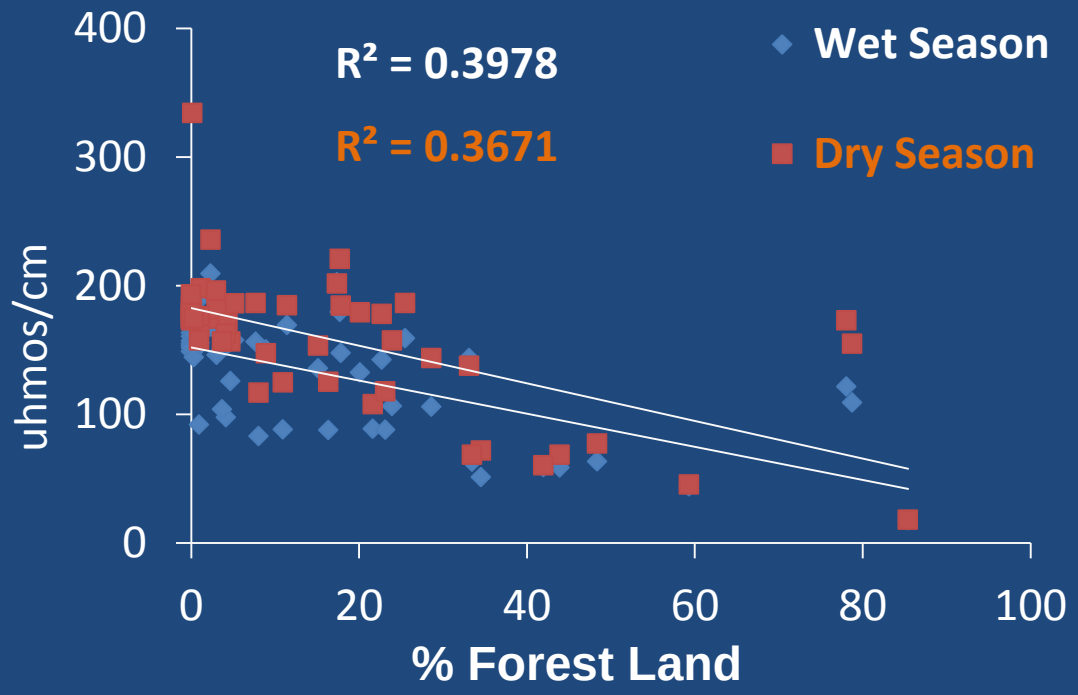


Source: Pratt and Chang *2012 J Haz Mat*

Land cover and conductivity

Riparian scale



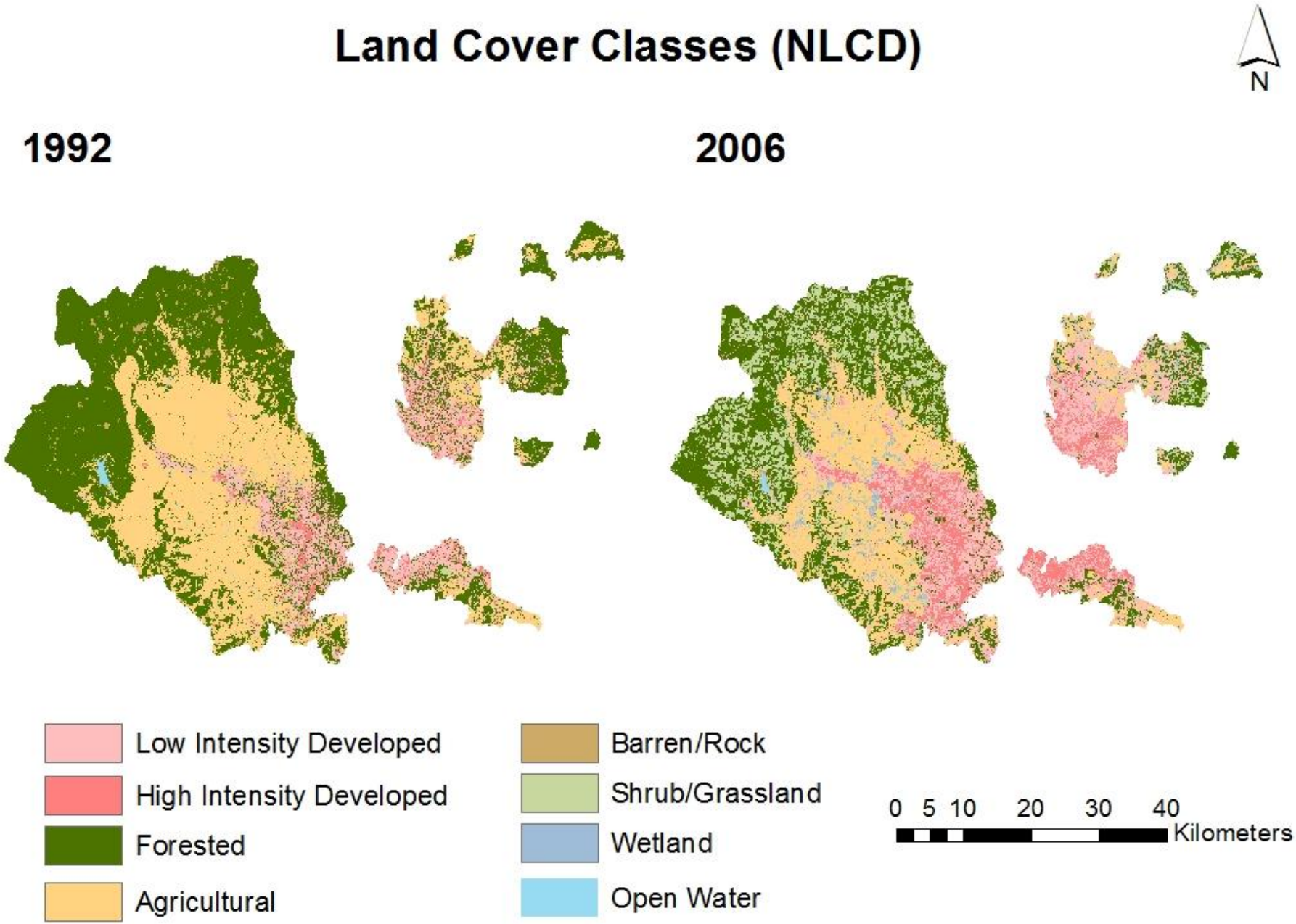


Wet Season Conductivity

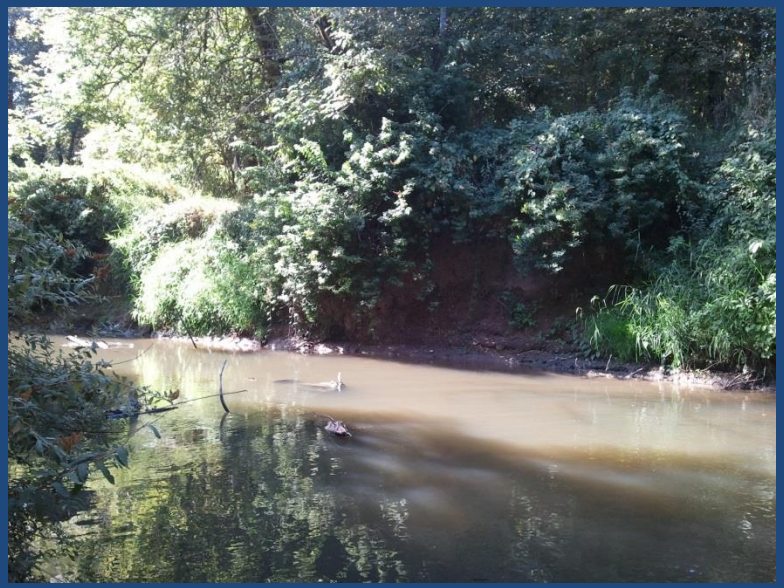
= 1.005 (% Urban) + 60.156

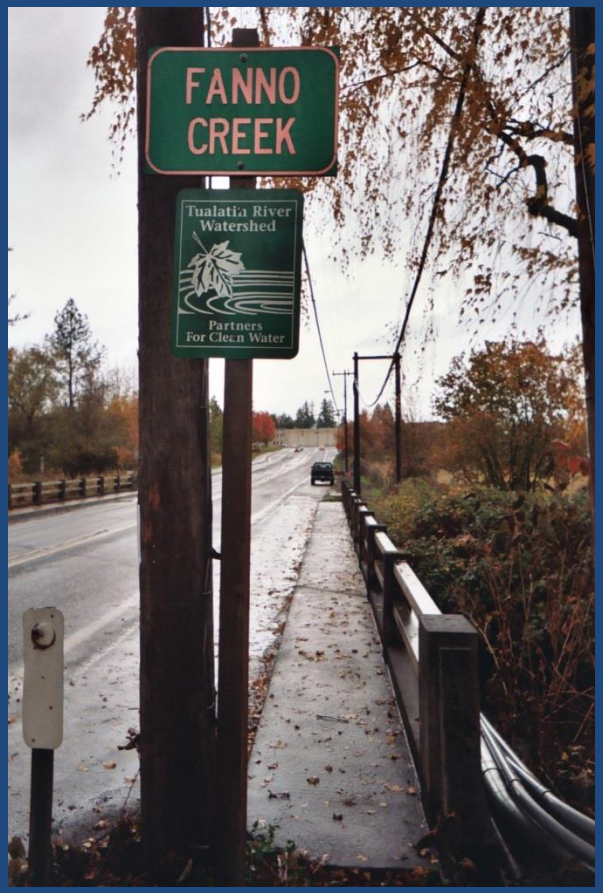
Adjusted R^2 = 0.5146

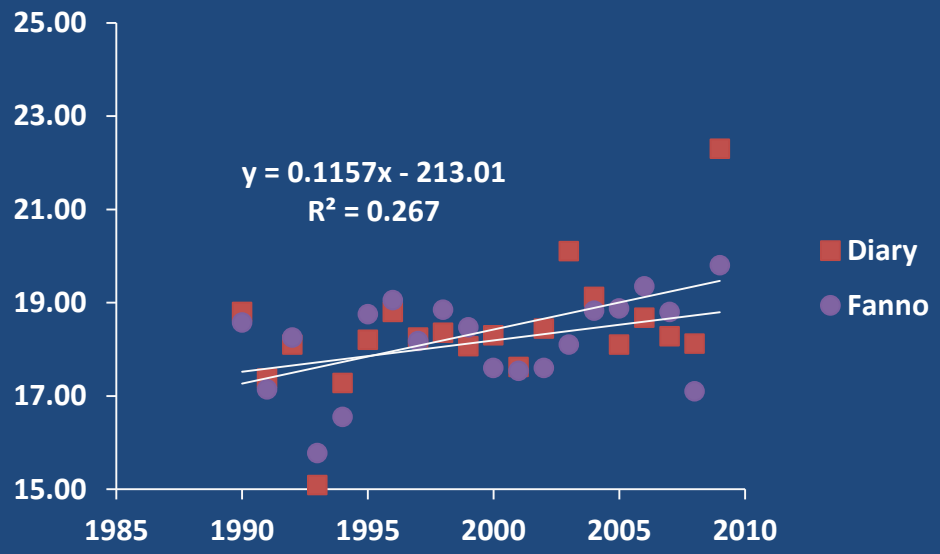
Land Cover Classes (NLCD)

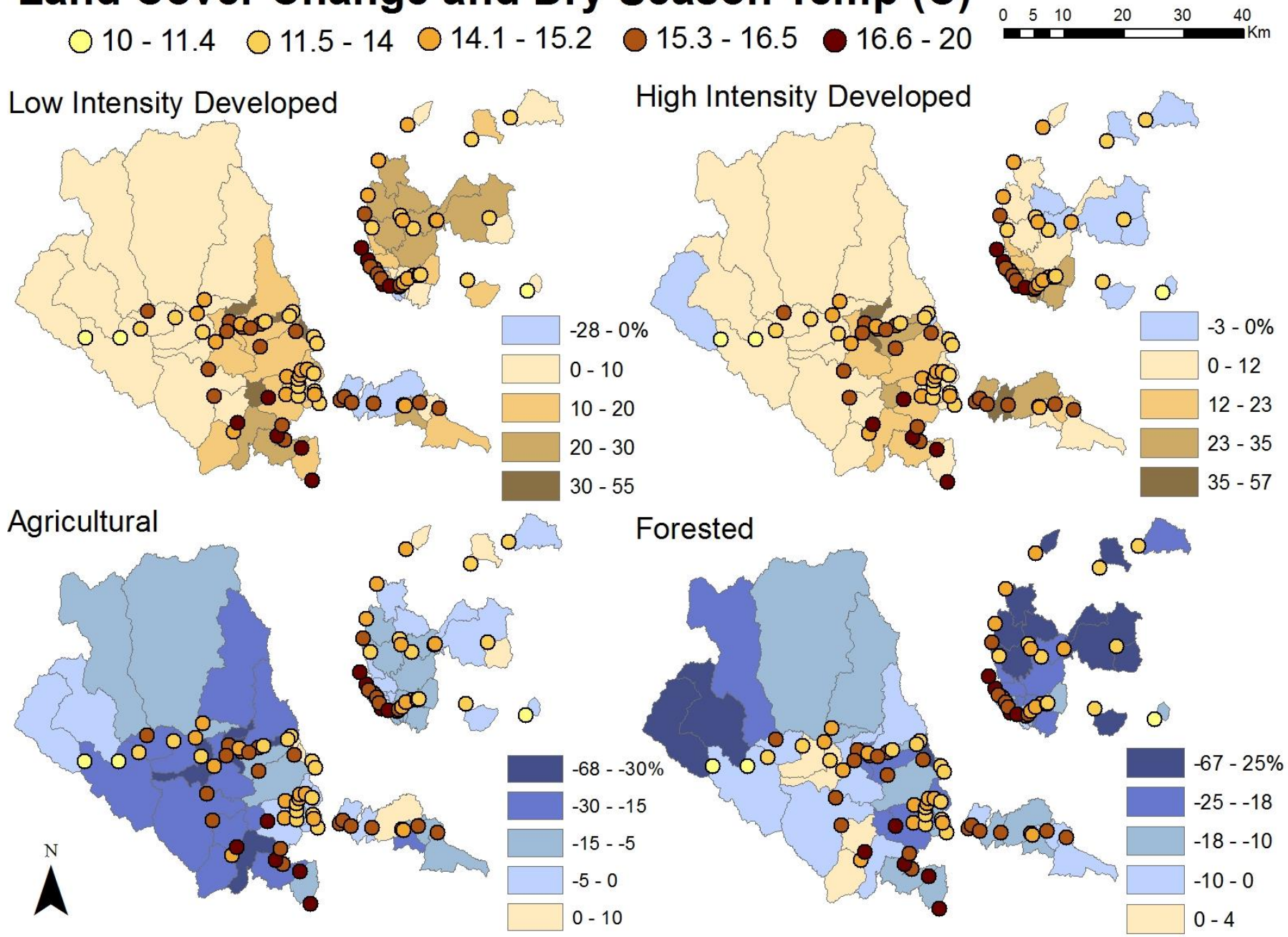


Change in stream temperature, 1990-2009

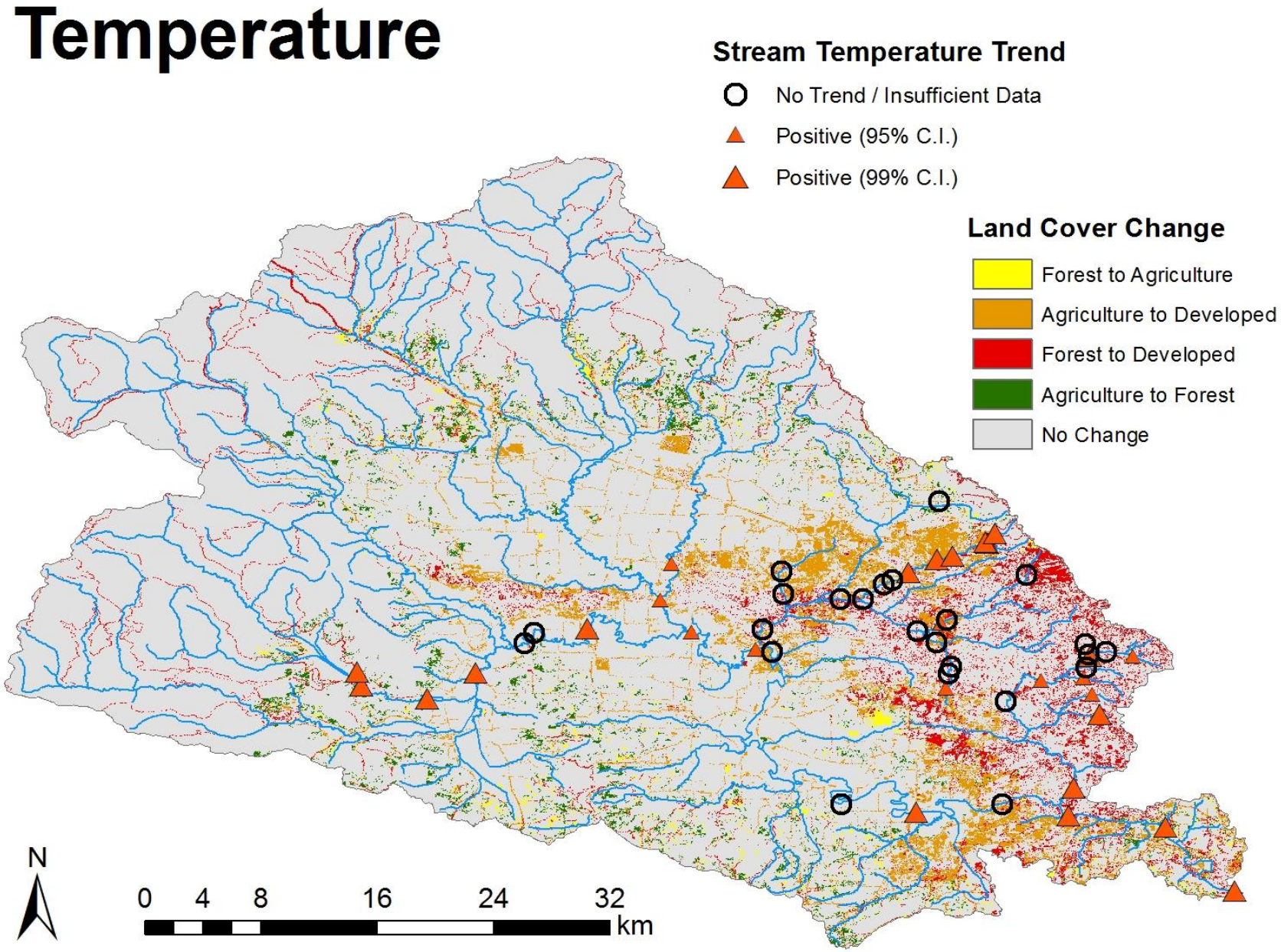




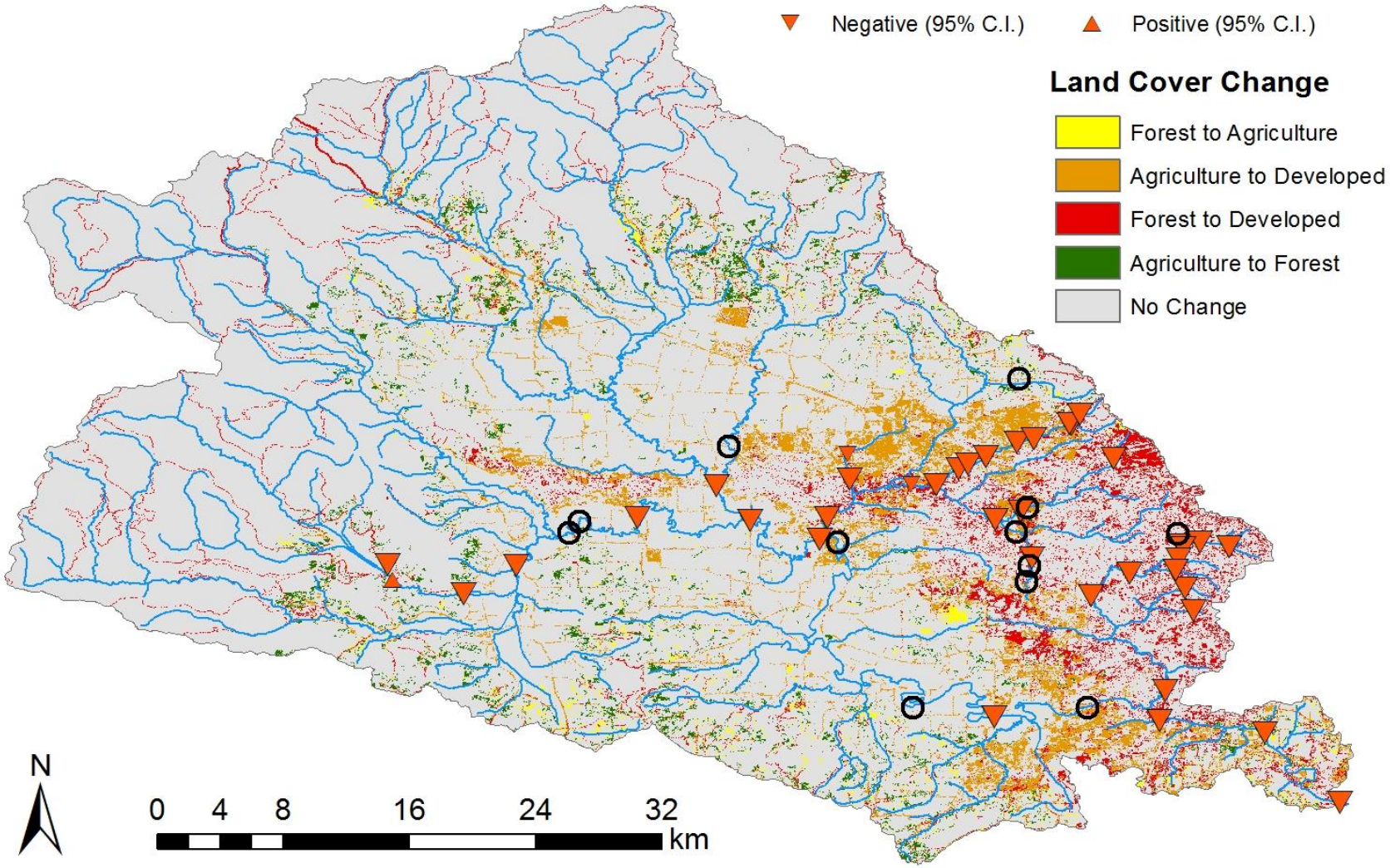



Land Cover Change and Dry Season Temp (C)
10 - 11.4
11.5 - 14
14.1 - 15.2
15.3 - 16.5
16.6 - 20
0 5 10 20 30 40
Km
Low Intensity Developed
-28 - 0%
0 - 10
10 - 20
20 - 30
30 - 55
High Intensity Developed
-3 - 0%
0 - 12
12 - 23
23 - 35
35 - 57
Agricultural
-68 - -30%
-30 - -15
-15 - -5
-5 - 0
0 - 10
N
Forested
-67 - 25%
-25 - -18
-18 - -10
-10 - 0
0 - 4

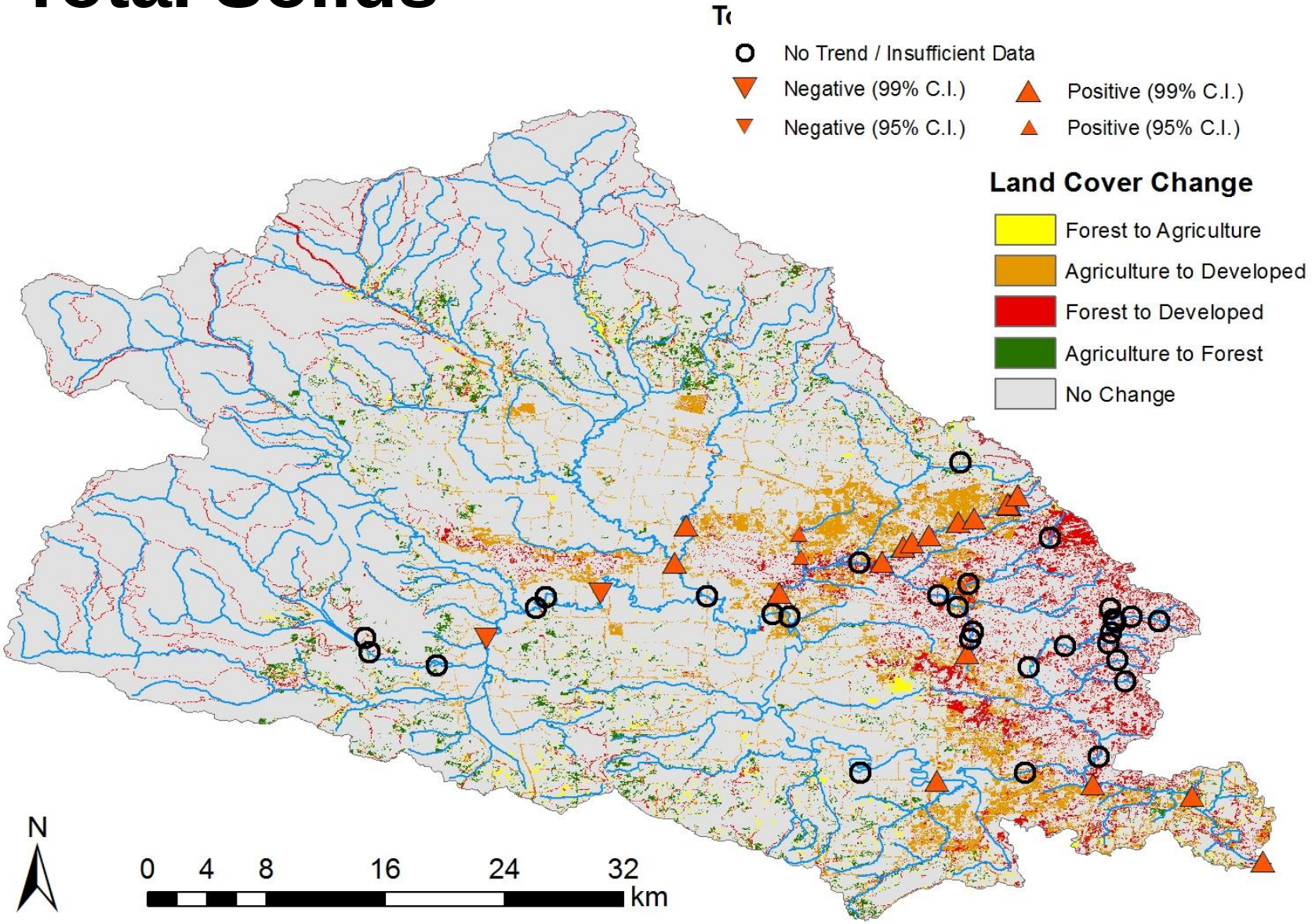
Temperature



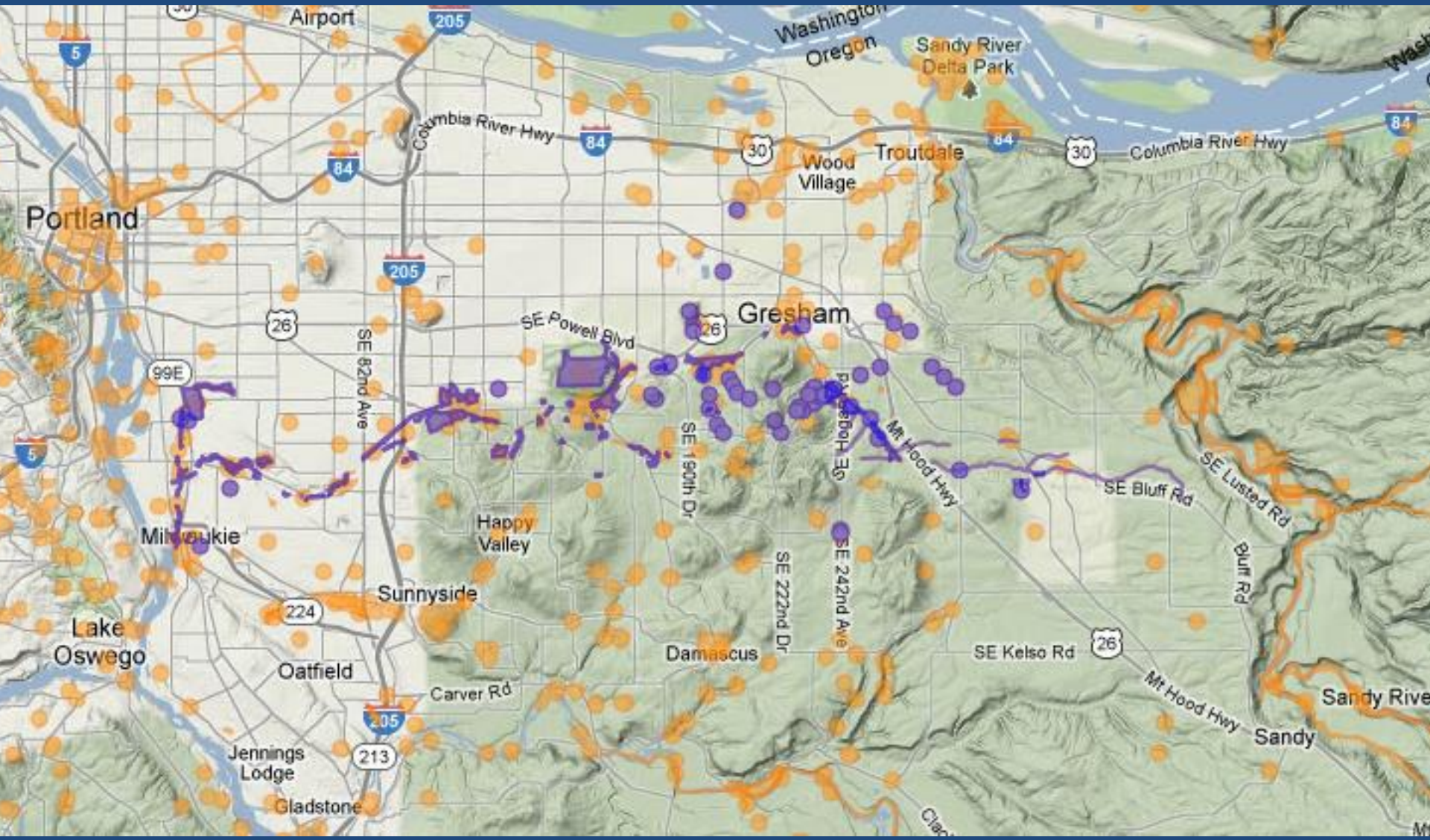
Dissolved Oxygen



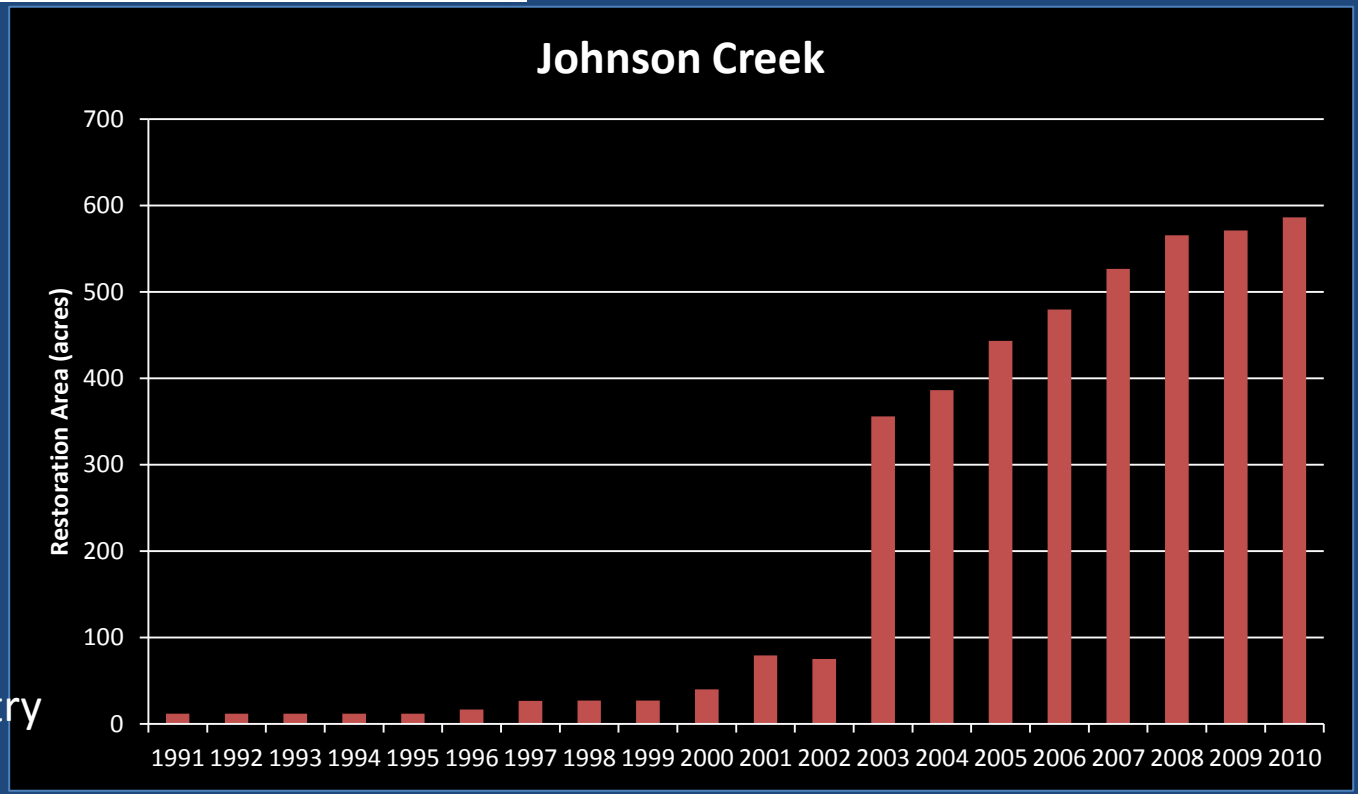
Total Solids



Restoration Projects Along Johnson Creek

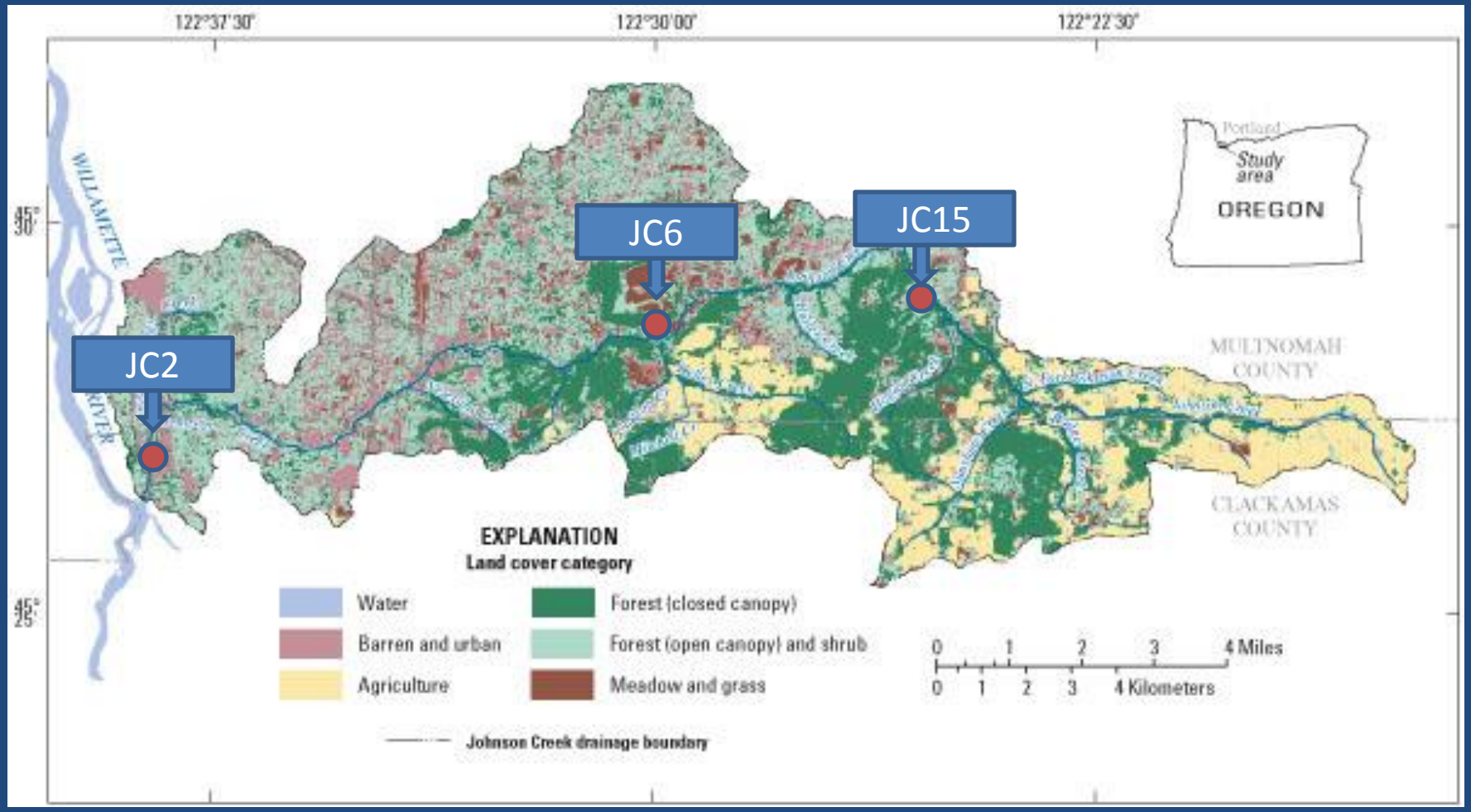


Cumulative restoration



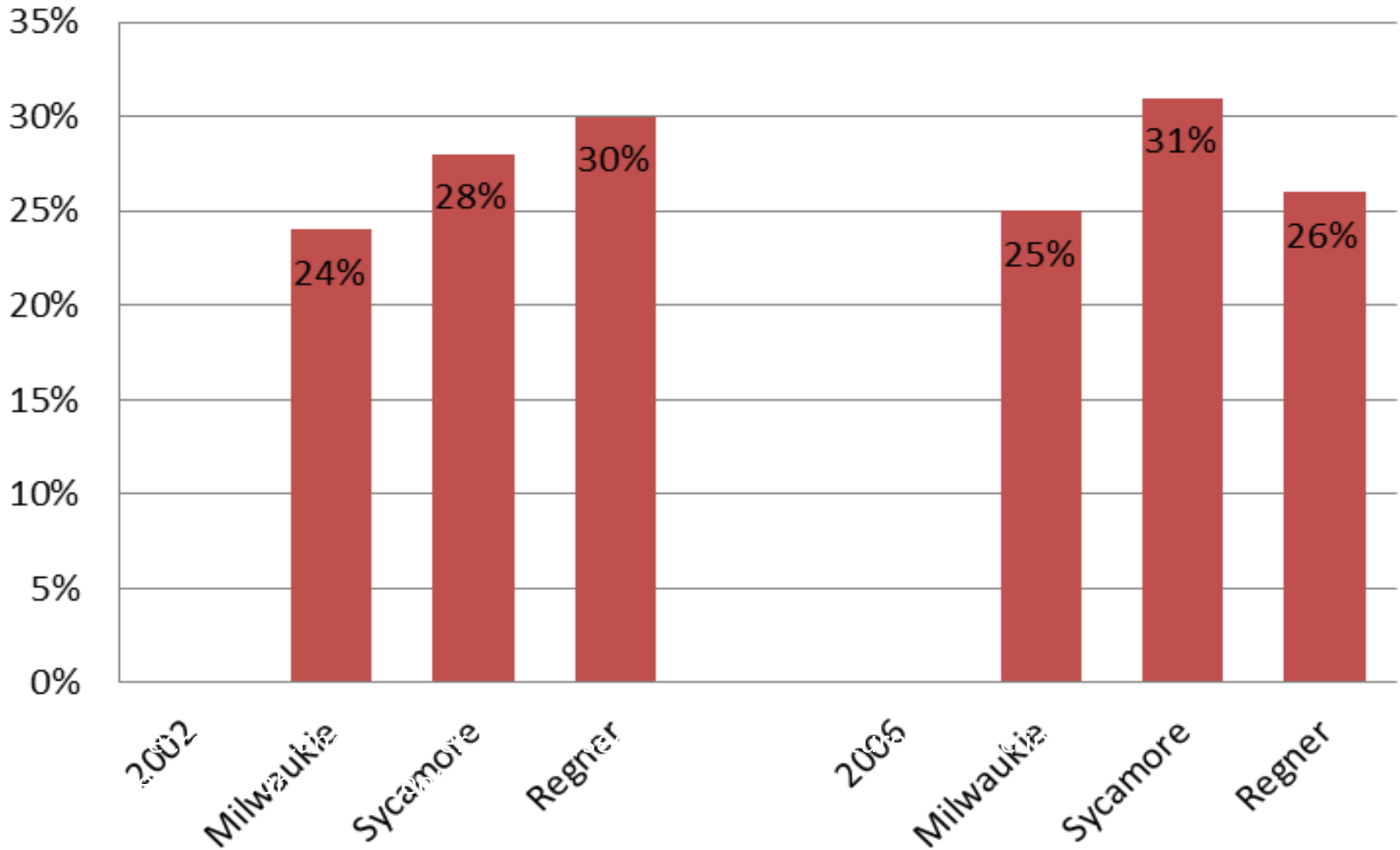
Source: Conservation Registry

Johnson Creek monitoring sites

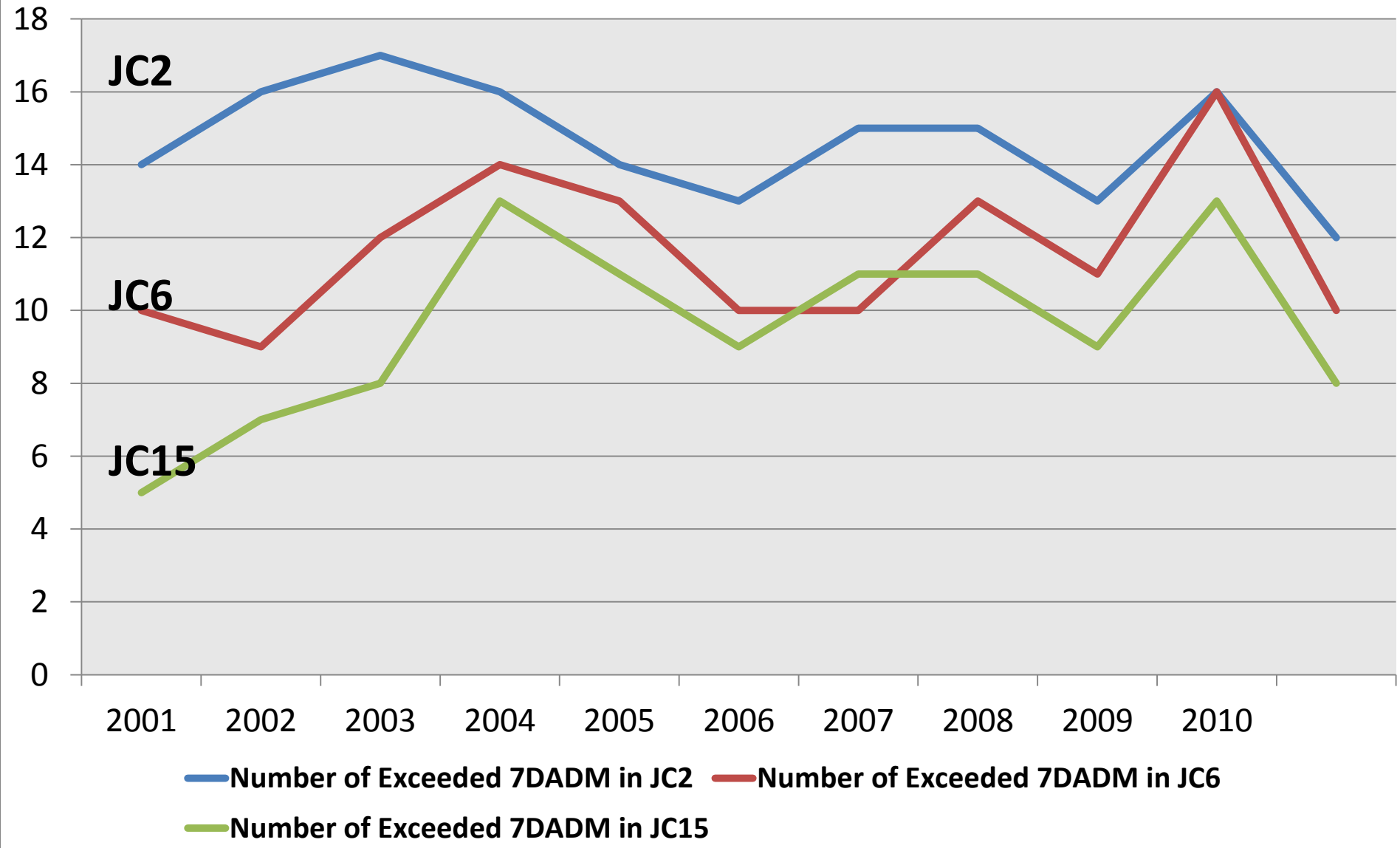


Map: USGS (2012)

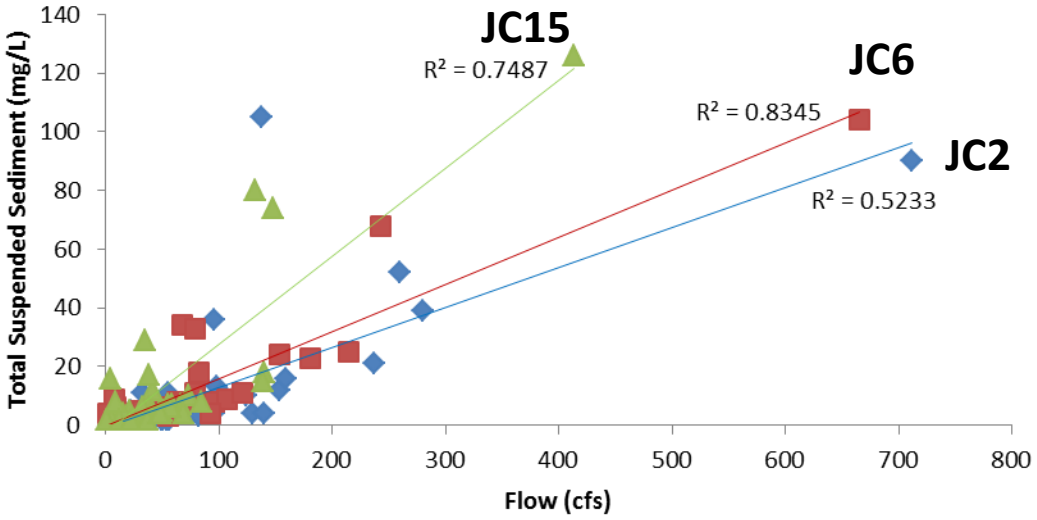
Change in canopy cover in riparian area



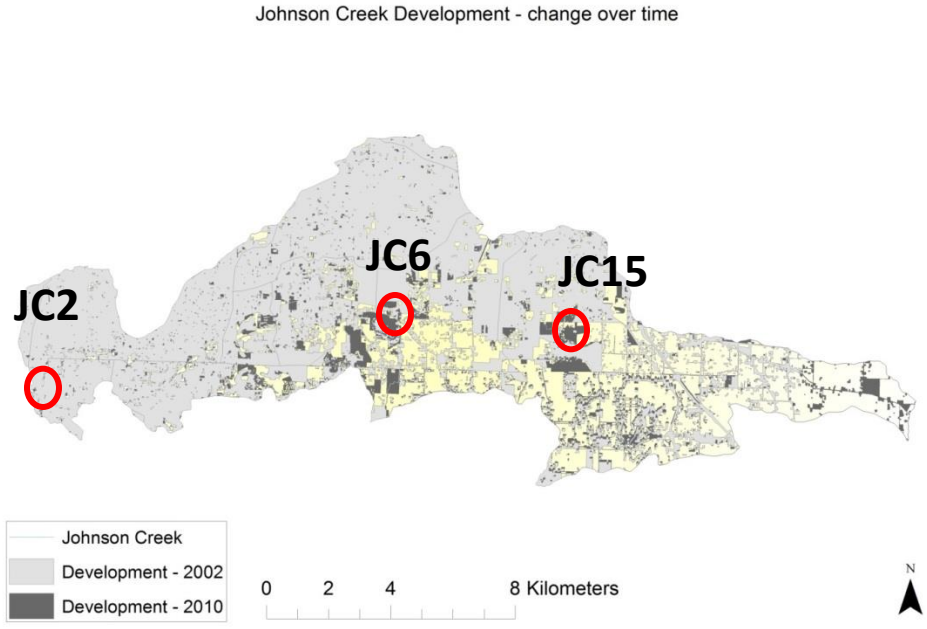
Number of Exceeded Weeks of 7DADM during Summer, 2001-2011

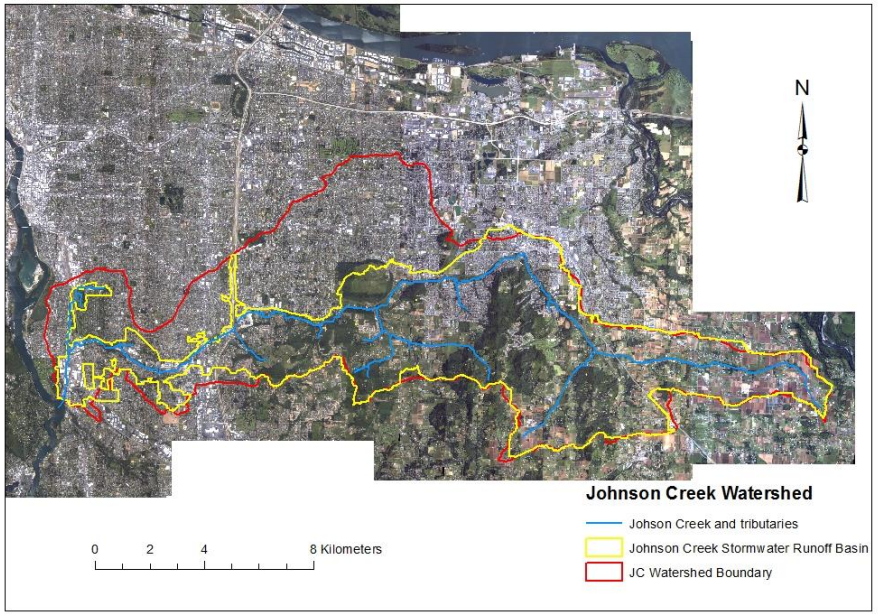


Spatial difference in Wet Season TSS/Flow Relationship, Johnson Creek 2003-2010

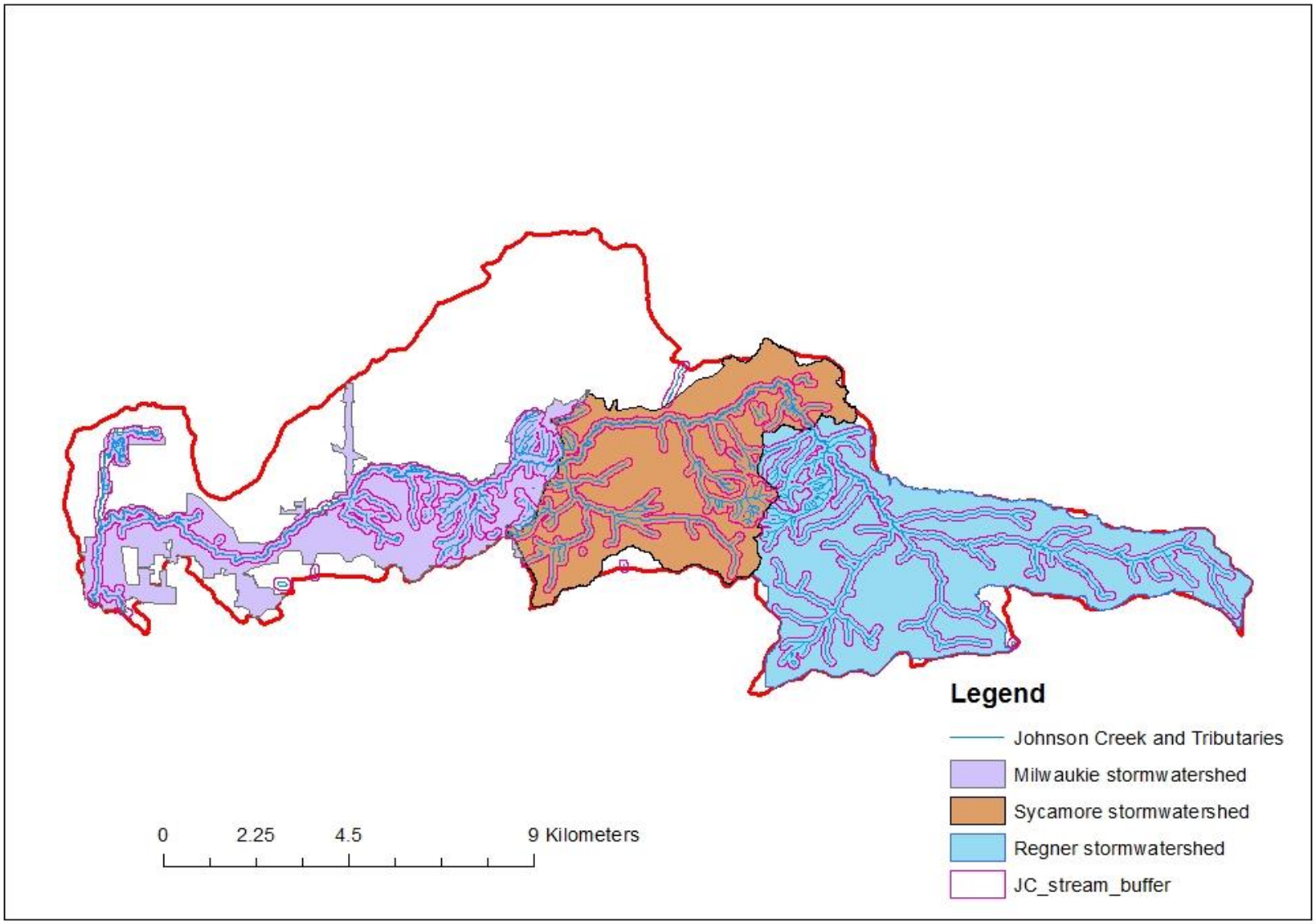


- JC2 (Milwaukie)
- JC6 (Sycamore)
- JC15 (Regner)





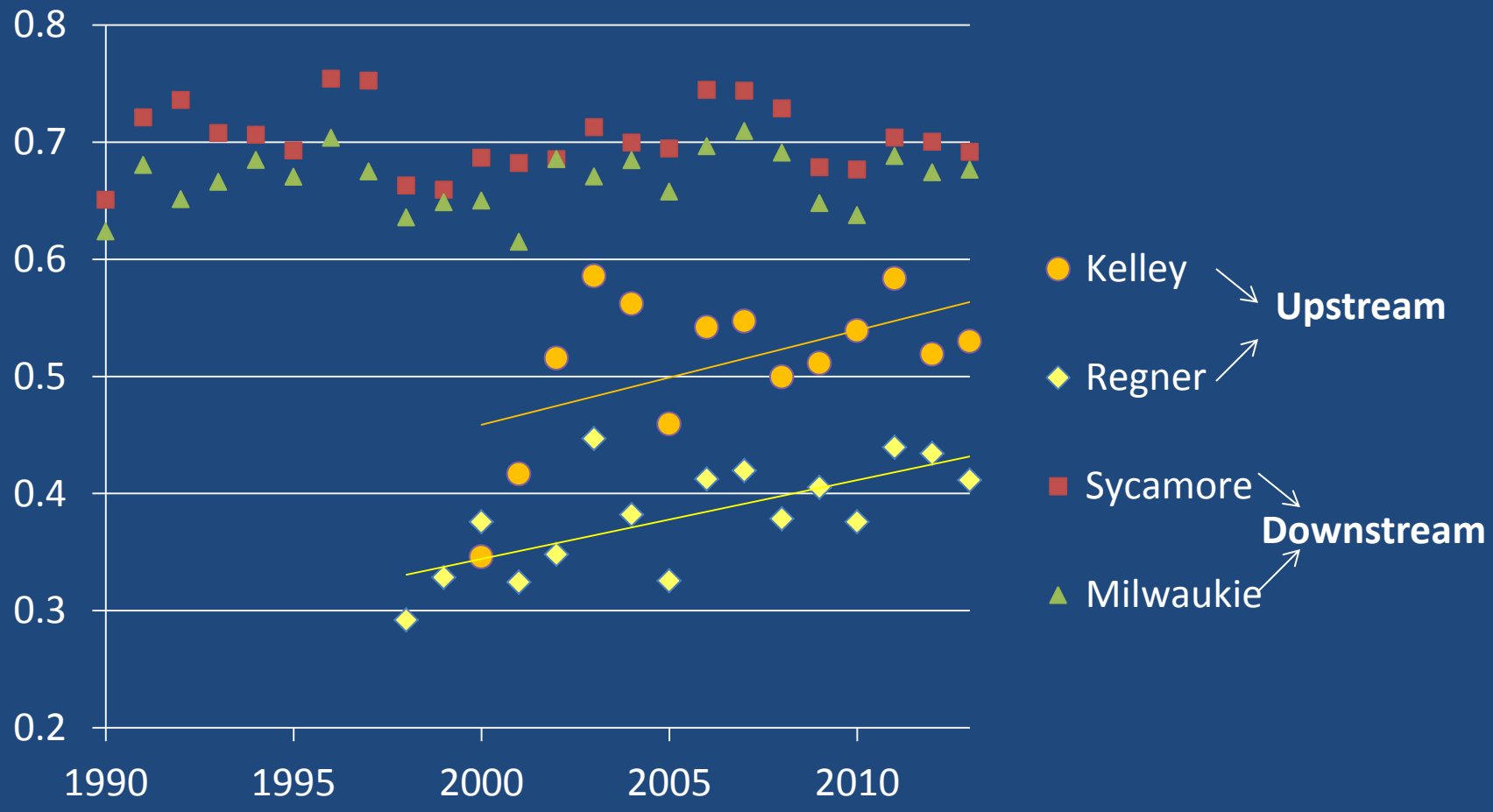
Buffer analysis



Within Stormwatershed →

Within 100m Buffer ↓

Change in flashness of flow, 1990-2013



$$R-B\ Index = \frac{\sum_{i=1}^{n} |q_i - q_{i-1}|}{\sum_{i=1}^{n} q_i}$$

Index based on Baker et al. 2004. JAWRA

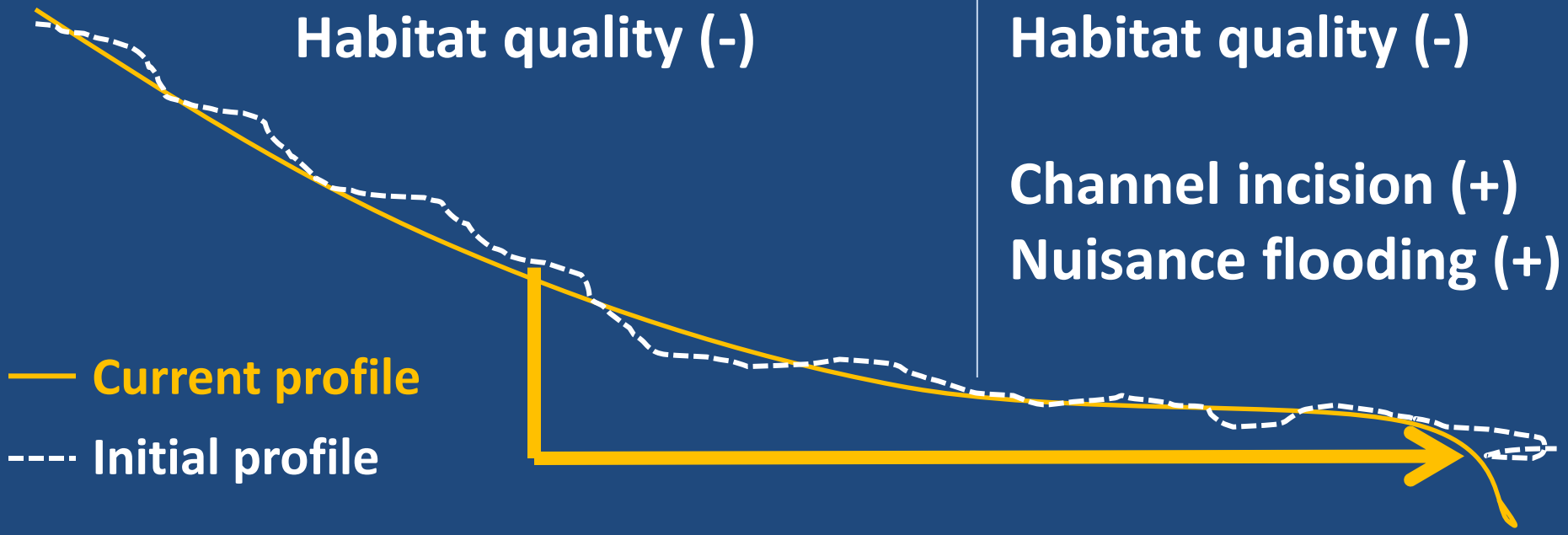
Results of land surface smoothing

Soil erosion (+)
Water retention (-)
Nutrient exports (+)
Plant production (-)
Groundwater recharge (-)
Habitat quality (-)

Water retention ?
Nutrient retention ?

Baseflow (-)
Habitat quality (-)

Channel incision (+)
Nuisance flooding (+)



Answering research questions

- Does the relationship between land cover and WQ vary across scales along an urban-rural gradient?

➔ Riparian land cover better explains the spatial variations of WQ.

- What is the trend of water quality?

➔ More than half of Tualatin tributary stations exhibit significant trends in many WQ parameters.

- Did land cover change affect water quality?

➔ Agricultural land conversion is strongly associated with changes in water quality, but the effect varies by parameter.

- What is the effect of restoration on stream water quality?

➔ It is early to tell the effectiveness of riparian restoration. Other confounding factors need to be considered.

Acknowledgements

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Clean Water Services
Clark County

Questions or comments:
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